AN ANNOTATED BIBLIOGRAPHY OF VOCABULARY-RELATED WORK PRODUCED BY THE JOHNSON O'CONNOR RESEARCH FOUNDATION

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Abstract

As director of electrical engineering research for General Electric in the 1920s, Johnson O'Connor developed a means of ascertaining which employees of the company were best suited for retraining in various areas. This task led him to the study of aptitudes and to the development of aptitude tests. Finding that vocabulary was the best single predictor of occupational success in all areas, O'Connor founded Human Engineering Laboratories in Boston to further study aptitudes and vocabulary. This organization, renamed the Johnson O'Connor Research Foundation after its founder's death in 1973, continues this work. This report contains annotations of all vocabulary-related work produced by the Foundation since its establishment.

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AN ANNOTATED BIBLIOGRAPHY OF VOCABULARY-RELATED WORK PRODUCED BY THE JOHNSON O'CONNOR RESEARCH FOUNDATION

Since 1927, the Johnson O'Connor Research Foundation (originally called Human Engineering Laboratories) has conducted extensive research related to vocabulary and to aptitudes. However, because most of this work was produced only as technical reports and statistical bulletins intended primarily for in-house use, few of the results of the Foundation's many investigations have come to the attention of other researchers. This annotated bibliography is an attempt to remedy this situation. It contains all of the sources I located in the Foundation's research department that deal at length with vocabulary. It is not, however, exhaustive of all works related to vocabulary that the Foundation has produced. Some of the sources cited in this bibliography deal also with topics other than vocabulary. When this was the case, I made no attempt to balance the annotation with respect to the source; rather, I emphasized the aspects of the source related to vocabulary.

About Johnson O'Connor and the Johnson O'Connor Research Foundation

After obtaining a degree in philosophy from Harvard, Johnson O'Connor worked for the astronomer Percival Lowell, conducting research in astronomical mathematics. He became interested in electrical engineering, and by the 1920s was director of electrical engineering research for General Electric (GE) in West Lynn, Massachusetts.

In 1922, GE's leadership decided that both the company and the employees would benefit if employees could be matched to positions that suited their natural abilities or if they could be retrained in areas appropriate to their talents as jobs involving newer technologies became available. Concluding that it would not be to the company's advantage to spend time and money retraining employees who were not suited to the new jobs, GE's management asked O'Connor to develop a means of ascertaining which employees would be best suited for retraining in which areas. This task led him to the study of aptitudes and to the development of aptitude tests.

Through his testing, O'Connor found that aptitudes are innate--that, for example, one who is mathematically inclined can learn about mathematics much more quickly and easily than can one whose mathematics aptitudes are low; that those who are not artistically or musically inclined, while they can improve their abilities in these areas through training, will never be great artists or great musicians. O'Connor also found that a person's vocabulary level was the best single predictor of occupational success in every area. He found, further, that unlike true aptitudes, the ability to acquire vocabulary was largely learned rather than aptitudinal.

In 1927, O'Connor founded Human Engineering Laboratories in Boston. This nonprofit research organization was devoted to the study of aptitudes and vocabulary. Renamed the Johnson O'Connor Research Foundation after O'Connor's death in 1973, the organization has continued this work. Its main office is now in New York City.

O'Connor's research led him to formulate to three principles of vocabulary acquisition. It should be noted that he did not develop theories about vocabulary acquisition and then design experiments in an attempt to verify these theories. Rather, he first collected empirical data about patterns of knowledge of thousands of vocabulary items from tens of thousands of people in all walks of life in diverse geographical areas of the United States. His principles evolved subsequently, based on this massive data base. Additional data collected from tens of thousands of additional subjects in subsequent decades have provided further support for these principles.

O'Connor's first principle is that each word has an inherent level of difficulty. That is, words can be placed in a list or on a graph ranging from easy, well-known words to difficult, almost unknown words (see Figure 1). The level of difficulty of each word can be determined by the percentage of people to whom the word is unknown. In general, the difficulty level of a particular word is strikingly consistent across both geographical areas and socioeconomic groups. That is, a word that is difficult is difficult for everyone.

O'Connor's second principle is that each person's word knowledge falls somewhere on that difficulty line. Each person will know virtually all of the words below his or her level, but will know relatively few of the words whose difficulty is much above his current vocabulary level. That is, the dropoff at each person's "vocabulary frontier" is quite sharp.

O'Connor's third principle is that a person's rate of learning will be greatest for words that are at or near her or his vocabulary "frontier." That is, it will be relatively easy for a person to learn new words just above or just below her current level; but it will be very difficult to learn words far above that level. (A corollary of this is that because most words below a person's level are already known, instruction in these words is largely a waste of time.)

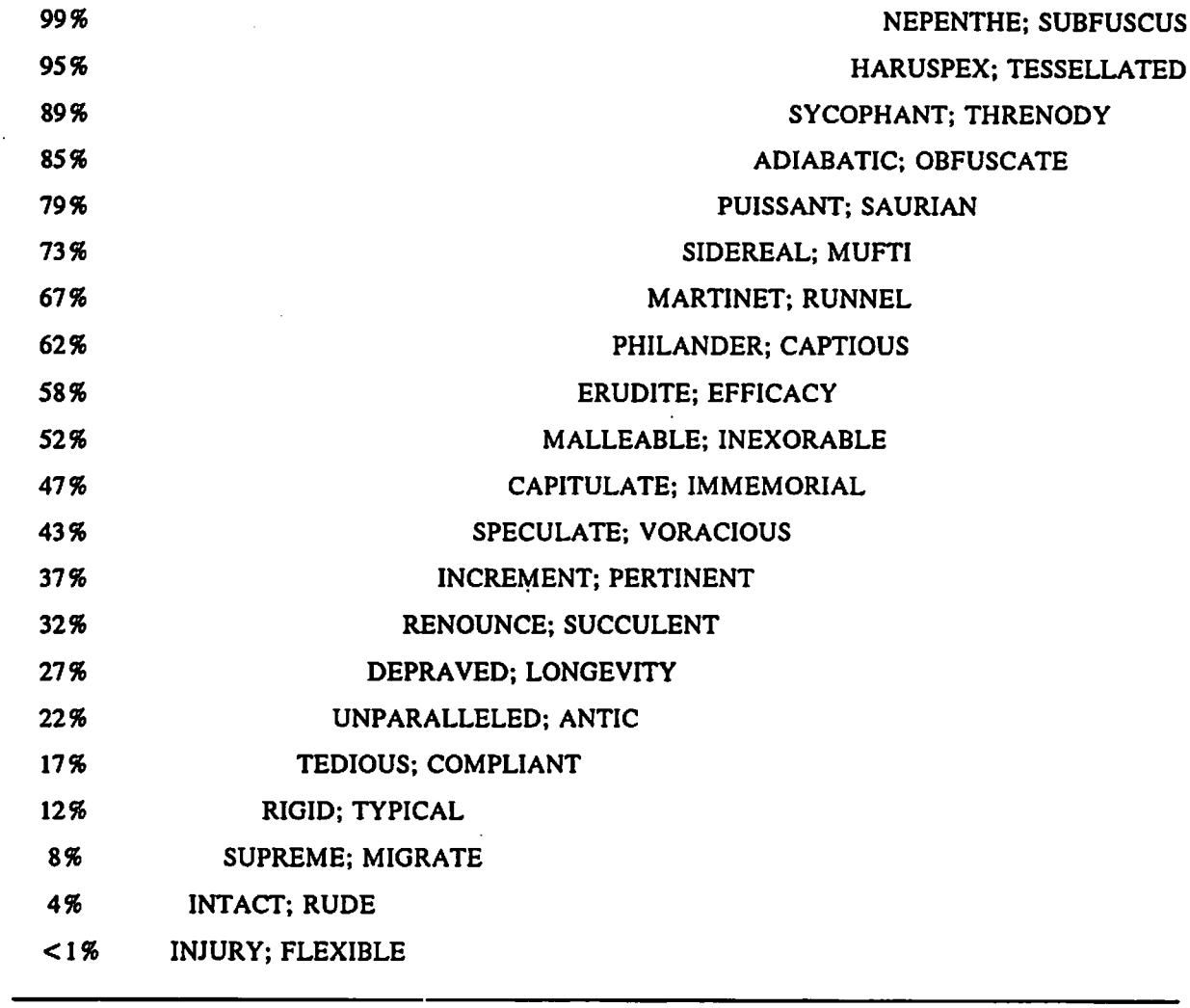
This is not to say that we cannot learn difficult words--words that are far above our current vocabulary level. However, researchers at the Foundation have found that the learning of such words will normally be laborious, and that most such words will soon be forgotten. Note that this accords nicely with what happens when you look up unknown words you encounter while reading. Suppose you make a list of perhaps 20 words you don't know and study them in an attempt to improve your vocabulary. If you happen across that list a year later, you are likely to remember the meanings of perhaps 3 or 4 of the words. What happened to the other 16 or 17 you spent time learning? O'Connor's third principle suggests the answer. The words you remember are those whose difficulty level is near your vocabulary frontier--you were *ripe* to learn them. However, you were not yet ready to acquire the other words because they were too far above your level.

O'Connor's principles have important implications for vocabulary instruction, and they apply both to direct instruction and to incidental vocabulary acquisition. The principles suggest that regardless of what techniques and materials are employed, the rate of acquisition will be maximized if each learner is presented with words at or near her current vocabulary level. Providing such words requires three things. First, the difficulty level of large numbers of words must be determined. Second, the student's vocabulary level must be determined. Third, since vocabulary levels differ widely from person to person, different students must receive different vocabulary. That is, maximally effective instruction is, almost necessarily, individualized instruction. The fact that most contemporary instructional programs fail to present words whose difficulty level is appropriate to each individual student can, by itself, account in large measure for the failure of most vocabulary studies that have assessed the impact of direct instruction to show particularly robust effects.

Researchers at the Foundation have found that word frequency, overwhelmingly the most commonly employed means of ascertaining word difficulty, is not adequate for determining word difficulty, the two showing a correlation of about .5. The inadequacy of word frequency for assessing word difficulty can be readily seen from examples. For instance, the word *Tuesday* occurs less than half as frequently as the word *Saturday* (Wesman & Seashore, 1949), but clearly is no more difficult. And *horseshoer*, while less frequent than *demographic*, is clearly much easier, being known to virtually all third graders.

Word length is virtually useless as a predictor of word difficulty, showing only a very weak positive correlation. Likewise "experts'" estimates of word difficulty are also inadequate. When several seventh- grade teachers were asked to provide a list of 150 words they thought would be easy for their students, only 12 of the 150 words the teachers agreed on were known by 90% of their students (Ginn, 1966a).

FIGURE 1
Word Difficulty*



*Y-axis is percent of adults who do not know word's meaning.

Foundation researchers maintain that when a person knows a word, he will be able to provide a synonym of that word or readily define it in a short phrase. Conversely, to the degree that a person cannot provide a synonym or clear definition of a word, he does not really know that word.

The Foundation's researchers have also found that the process of acquisition of a word normally involves stages in the development of the knowledge of that word. There thus is consistency in how words are misunderstood. Students are likely to confuse words that are similar in sound, especially if both are unknown (e.g., *haggard* and *haggled*). They also tend to confuse words whose meanings partially overlap (e.g., *revelry* and *joyfulness*), as well as words that are used in similar contexts (e.g., *satire* and *irony*). Mistaking a word for its antonym is also a natural step on the way to learning the word. Each of these findings suggests sources for effective distractors in tests of vocabulary knowledge, an area Foundation researchers have investigated more thoroughly than probably any other group in the field.

The Foundation's findings do not suggest that all people learn all words in exactly the same order. But the overall pattern of order of acquisition of general vocabulary is remarkably similar across individuals. If a student knows a group of words at a certain difficulty level, it is predictable that she'll know virtually all words that are below that level.

Notes on the Bibliography

Many of the sources use the word *Worksample*. Worksample is the term the Foundation uses for its assessment instruments (e.g., aptitude tests and vocabulary tests). The term *silogram* also appears on occasion in the bibliographical entries. A silogram is an item developed by HEL to measure aptitude at learning new words in a foreign language. It involves recalling English words paired with nonsense words using the nonsense word as the prompt. Also, several of the sources refer to the Scholastic Aptitude Test (SAT). Because different sources used different versions of the test produced in different years, no date is listed for the SAT in the reference section.

I wish to thank the members of the Chicago office of the Foundation, especially Dr. Robert Kyle, for allowing me access to these materials and for the use of the Foundation's facilities. Those wishing additional information regarding sources referenced here are encouraged to contact the Research Department, Johnson O'Connor Research Foundation, 161 E. Erie, Chicago, IL 60611.

ANNOTATIONS OF JOHNSON O'CONNOR WORK RELATED TO VOCABULARY

Alfano, M. V. (1939a). *English vocabulary distributions for twenty-nine secondary schools: Worksample 95, Form E* (Tech. Rep. #33). Boston: Human Engineering Laboratories. Predicated on the principle that attending an appropriate school will provide maximum opportunity for vocabulary growth, the study examined the vocabulary scores of students in 29 schools in the eastern half of the U.S. as part of a program designed to recommend schools to Human Engineering Laboratories (HEL) examinees. The premise of the study is that a student placed with students whose vocabularies are too far above him will be impeded in vocabulary development because he will not be able catch up or keep pace. Similarly, a student placed in a class with students whose vocabularies are far below him will suffer because he will not be exposed regularly to the words he is ready to learn. The study attempts to measure vocabulary increases across school years for the schools, but because it is cross-sectional it is limited as a vehicle for determining the effectiveness of a school's vocabulary instruction. Notes that previous research (Tech. Rep. #8) has found that students' vocabularies grow most rapidly when they are in classes in which the mean vocabulary score approximates their own. Suggests that a student whose vocabulary is in the top 15% of his class will probably not be adequately stimulated or challenged, while one whose vocabulary falls within the bottom 20% will be overwhelmed. Finds that those in the top 15% or the bottom 20% have a 70% chance of failure.

Alfano, M. V. (1939b). *Variation of vocabulary scores with age and schooling: Worksample 95* (Tech. Rep. #35). Boston: Human Engineering Laboratories. Presents data on the relation of scores on six forms of Worksample 95 to age and formal education. Argues, based on these data, that vocabulary is not an inherent trait, but is learned. Claims that vocabulary level is not simply a function of age nor of schooling, and suggests the need for further research to test the possibility that word learning rate may be affected by aptitude, opportunities to encounter new words to learn, schooling, home environment, availability of library facilities, and so forth. Provides numerous graphs of vocabulary knowledge as a function of age, though number of subjects per groups is somewhat small in many instances.

Alfano, M. V. (1939c). *Variation of vocabulary scores with age, sex, and schooling: Worksample 176* (Tech. Rep. #36). Boston: Human Engineering Laboratories. Reports data on the variation of junior English vocabulary scores with age, sex, and formal education. Notes that this vocabulary test was constructed to measure more accurately and reliably the vocabularies of subjects who were below the general English vocabulary test level. Finds no solid evidence of a sex difference for vocabulary level. Provides numerous tables of vocabulary scores by age that examine differences between Worksamples 176 and 95. Concludes, in general, that Worksample 176 is inferior to Worksample 95 for detecting vocabulary improvement except for examinees below age 12 or for those with low scores on Worksample 95.

Anderson, J. D. (1973a). *An examination of the age of words* (Tech. Rep. #822). Boston: Human Engineering Laboratories. Examines the length of time that various words have been in the English language and correlates it with word difficulty. Finds a slight trend for very easy words to be older than difficult words. Notes that the easiest words (1st- and 2nd-grade level in the Ginn reading series), as a group, are 438 years older than the intermediate (7th-grade level) words, which in turn are 77 years older as a group than more difficult words. Finds no clear tendency for easier words to be older among words within the difficult words in the Ginn series. (See also Tech. Rep. #673.)

Anderson, J. D. (1973b). *A study of the Johnson O'Connor English vocabulary builder, I-II, and the Brown University standard corpus of present-day edited American English* (Tech. Rep. #823). Boston: Human Engineering Laboratories. Compares O'Connor's English Vocabulary Builder, Volumes I and II, with the Kucera-Francis (1967) data. Reports that 78% of the words in Volume I and 44% of the words in Volume II appear in the Kucera-Francis list with the same morphological form (= 61% for both volumes). Also reports that if a morphologically related variant is counted as equivalent, 91% of Volume I words appear and 63% of

Volume II words appear (= 77% for both volumes). Notes that a reader who reads 1 million words still would not encounter approximately 23% of the words that occur in the first two volumes of O'Connor's vocabulary program. Raises questions as to whether the words in the 23% that do not appear in the Kucera-Francis data are "significant words" and, if they are, whether reading is a sufficient means of improving vocabulary. Finds a positive relationship between frequency and word difficulty (a fact long known). Also concludes (without adequate basis or justification) that more than just reading is necessary for adequate vocabulary growth. Provides a list of 149 "relatively easy" words from O'Connor's system which, because they occur frequently in the Kucera-Francis data, are presumably suitable for vocabulary instruction with low vocabulary learners. (See Tech. Rep. #823.)

Anderson, J. D. (1974). *SATs and English vocabulary compared* (Statistical Bulletin #1974-12). Boston: Human Engineering Laboratories. Finds correlation of .76 between SAT-Verbal and the Foundation's English vocabulary General Scale Scores for 91 males and females aged 16-25.

Anderson, J. D. (1976a). *Foreign language study, English vocabulary and language learning aptitude (silograms)* (Tech. Rep. #838). Boston: Human Engineering Laboratories. Expands on Statistical Bulletin #1974-3, which examined correlations in 485 young men and women between foreign language study, particularly Latin, and English vocabulary. Notes that approximately 52% of English words are derived from Latin. Reports that those subjects who studied Latin and other languages had the highest vocabulary score average (on HEL tests); those with no Latin, but with other foreign language training had second highest; worst were those who had not studied a foreign language. (This should probably not be interpreted as causal because those with limited verbal ability are probably less likely to study a foreign language.) Notes that women performed better than men on the Silogram Worksample (recalling English words paired with nonsense words using the nonsense word as the prompt), with approximately 75% of the females performing above the median male score and that those who studied Latin were highest in language learning aptitude (based on Silogram score). Finds positive correlation between extent of foreign language training and English vocabulary level, but finds no indication that length of foreign language study affects language learning aptitude.

Anderson, J. D. (1976b). *English vocabulary level of five public high school Latin classes* (Tech. Rep. #841). Boston: Human Engineering Laboratories. [A follow-up to Tech. Rep. #838.] Reports findings from a study in which 485 students were tested and finds that "those with training in Latin and some other foreign language(s) have the highest level of proficiency in English vocabulary" (p. 1). Concludes that foreign language training, especially Latin, is beneficial for building English vocabulary.

Baker, R. H. (1940). *Growth curves of seven aptitudes and vocabulary* (Statistical Bulletin #561). Boston: Human Engineering Laboratories. Provides data showing faster acquisition rates based on the Foundation's English vocabulary General Scale Score for higher than lower percentile scorers across ages from 8 to 50.

Bittel, J. A. (1947). *100 words to be used as substitutions for stimulus words on Worksample 35* (Tech. Rep. #388). Boston: Human Engineering Laboratories. Provides a list of 100 words for use in testing young children. Notes that the words were selected from a list of 2,596 compiled by the Child Study Committee of the International Kindergarten Union, and that they are words that had been judged easy and that had not been used in any of the forms of Worksample 35.

Bowker, R. (1975a). *English vocabulary comparison of Latin and non-Latin students* (Tech. Rep. #831). Boston: Human Engineering Laboratories. Reports that high school juniors who had studied Latin for two years scored significantly higher on an English vocabulary test than did those who had not. Argues that because the Latin group's score was higher for non-Latin-derived as well as for Latin-derived words, studying Latin fosters "a more general word-awareness" (p. 3). Also finds a .52 correlation between vocabulary level and class rank. (Fails to mention possible selection bias: Those who take Latin may tend to be higher vocabulary individuals to begin with.)

Bowker, R. (1975b). *Nelson-Denny Vocabulary Test and Human Engineering Laboratory vocabulary tests compared* (Statistical Bulletin #941/1975-20). Boston: Human Engineering Laboratories. Finds a correlation of .91 between Nelson-Denny (Brown, Bennett, & Hanna, 1981) and HEL vocabulary tests for 105 examinees and notes that English vocabulary knowledge of Laboratory examinees is above average. Cautions about the use of HEL norms and, to a lesser degree, Nelson-Denny norms beyond age 16, because in both cases samples may not be representative of national population norms.

Bowker, R. (1975c). *Prediction of SAT verbal scores from General Scale scores* (Statistical Bulletin #951/1975-30). Boston: Human Engineering Laboratories. Finds a correlation of .85 between SAT-Verbal score and the Foundation's English vocabulary General Scale score for 100 students aged 16-18.

Bowker, R. (1976). *Standards for vocabulary test construction and revision* (Tech. Rep. #843). Boston: Human Engineering Laboratories. Presents and explains the Foundation's policies regarding construction and revision of vocabulary tests. Suggests that "If there is a way in which an individual might misunderstand the meaning of a word, that misunderstanding should be represented by a mislead, so that only the individual who knows the exact meaning of the word will get it right" (p. 1). Presents a set of 12 criteria to aim for, but recognizes that a perfect test cannot be constructed. Among the criteria listed are: the test phrase should be "colorless," the misleads and the correct choice should fit the test phrase equally well, and all choices should be simpler than the test word. Discusses partial word knowledge and the revision of tests through item analysis using statistics and judgments to bring tests closer to ideal standards. Suggests a sample size of 200 as the minimum number of cases for item analysis and presents fairly extensive procedures for same.

Bowker, R. (1977a). *Comparison of the vocabulary knowledge of high and low verbal-SAT students* (Tech. Rep. #854). Boston: Human Engineering Laboratories. Examines word-knowledge patterns of 28 high scorers and 28 low scorers on the SAT-Verbal to determine which words are known to the high scorers but not to the low scorers. Notes that there are some words that are known to almost all in the high group, but to few in the low group and that set of words is best at separating the two groups. Suggests that set of words should be known or learned by those hoping to get a high score on the SAT, and that another set of words, those known to some of the high group but to none of the low group, might be suitable for distinguishing within the high group. Observes that words in this latter set should not be studied by a student whose SAT score is in the 400 range, because they would be beyond the student's level. Notes the possible benefit of arranging a list of words by their equivalent SAT-Verbal value so that students who have taken the test would have a good idea of which words would be most appropriate for them to study to raise their scores. Contains a table of the 150 words on Worksample 95, Form AD, showing the number of students in the high-SAT group and the number of students in the low-SAT group who got each word correct.

Bowker, R. (1977b). *Scholastic Aptitude Tests, vocabulary and aptitudes: A preliminary study* (Tech. Rep. #861). Boston: Human Engineering Laboratories. Finds correlations between .81 and .85 between HEL vocabulary tests and the SAT-Verbal, and a .47 correlation between vocabulary and SAT-Math for 100 HEL examinees and two groups (N=87 and N=76) of high school seniors. All samples were above national averages, perhaps limiting generalizability of results. Suggests that the high correlation between vocabulary scores and SAT-Math scores supports HEL's contention that vocabulary is important for all school subjects.

Bowker, R. (1980a). *The relationship of word frequency, part of speech, length, and derivation to difficulty level* (Tech. Rep. #871/1980-3). Boston: Human Engineering Laboratories. Reports that for 1,080 words whose difficulty was approximately Grades 7-12, correlations between word difficulty and word frequency were .46 (with Kucera & Francis, 1967), .53 (with Thorndike & Lorge, 1938/44), and .62 (with Carroll, Davies, & Richman, 1971). Finds that nouns as a class are easier than adjectives or verbs. Finds no relation between word length or derivation and word difficulty, but notes that a relationship might appear if the range of words were extended. Concludes that, "Frequency accounts for between 21 and 38 percent of the variance in vocabulary scale level estimates of words included in the Wordbook program" (p. 3).

Bowker, R. (1980b). *Vocabulary instruction: The state of knowledge* (Tech. Rep. #1980-4). Boston: Human Engineering Laboratories. Examines what has been learned about the teaching of vocabulary since Petty, Herold, and Stoll's 1968 study. Discusses limitations of most studies and examines presentation of words in context versus use of definitions. Notes that recent studies support Petty et al.'s conclusion "that the evidence against the teaching of words in context was 'something of a fluke'" (p. 3). Observes that the value of pictures and imagery to vocabulary development is less clear than is the value of using words in context. Suggests that the success of different approaches to vocabulary instruction may vary for students with different cognitive styles and that assessment of cognitive styles could be useful for developing a good individualized vocabulary instruction program. Discusses Carey's (1978) notion of fast mapping and suggests that gradual acquisition of word knowledge is suggestive of the potential benefits of providing direct instruction, particularly for partially known words.

Bowker, R. (1980c). *Validity of English vocabulary tests* (Statistical Bulletin #1108/1980-34). Boston: Human Engineering Laboratories. Discusses content, convergent, and criterion validity of the Foundation's vocabulary tests. Regarding content validity, notes that Foundation tests measure reading vocabulary, measure breadth rather than depth of vocabulary knowledge, and (in the case of polysemous words) test for a single meaning. Regarding convergent validity, notes high correlations with other standard tests, based on other Foundation studies (e.g., .91 with Nelson-Denny vocabulary and .79 with the SAT), and suggests that although the tests differ in approach, they are all measuring the same trait. Examines criterion validity for occupations, and notes that Foundation samples may not be representative of occupation populations, but that they are in close agreement with U.S. Employment Service data for various occupations. Argues that the data suggest that vocabulary level is an important factor in occupational success. Also notes high correlation between vocabulary knowledge and intelligence test scores, suggesting that "most intelligence tests are primarily measures of verbal ability" (p. 8). Notes high correlations between Foundation vocabulary test scores and reading measures and between vocabulary scores and academic success in various school subjects, including courses that do not emphasize language usage, such as chemistry.

Bowker, R. (1981a). *A study of the effectiveness of Wordbook, the Johnson O'Connor Research Foundation vocabulary building program* (Tech. Rep. #1981-1). Boston: Human Engineering Laboratories. Finds significant improvement in vocabulary knowledge and reading comprehension for junior high school students who used Wordbook 1 hour per week for about 3 months relative to controls for both general vocabulary and for specifically taught words. Finds improvement even for students who were inappropriately placed according to O'Connor's theories.

Bowker, R. (1981b). *Aptitudes and length of education* (Tech. Rep. #880/1981-7). Boston: Human Engineering Laboratories. Tests 377 Foundation examinees aged 25-40, with a mean education of four years of college, and finds that vocabulary and three aptitude tests scores (personality, silograms, and ideaphoria) account for 24% of the variance in length of education. Finds that vocabulary correlates most highly ($r = .43$) of the factors examined. Notes similarity to findings of Jencks et al. (1979).

Bowker, R. (1981c). *Average vocabulary percentiles for various levels of education* (Statistical Bulletin #1117/1981-9). Boston: Human Engineering Laboratories. Finds a correlation between years of school and average vocabulary size, but notes very large range for all groups (less than 12 years through Ph.D.) and inability to infer causality. "A higher vocabulary may enable one to obtain more education, or education may increase one's vocabulary, or (as is probably the case), both may be true" (p. 2). Notes that one can have a high vocabulary with little formal education, a very low vocabulary with a great deal of education.

Bowker, R. (1989). *Vocabulary as a predictor of your SAT-Verbal score* (Statistical Bulletin #142). Chicago: Johnson O'Connor Research Foundation. Notes the importance of vocabulary for academic success, that vocabulary can be improved at a faster than normal rate through study, and that this is particularly important for low-vocabulary students, especially during the years prior to college entrance. Notes a high correlation

between scores on the O'Connor test and the SAT-Verbal score for approximately 100 high school students who took the SAT a month after taking the Foundation test, and includes a chart to convert between the Foundation's Vocabulary Scale Score (VSS) and SAT-Verbal score. Notes that there is a set of words known to high-SAT verbal scorers but not to low-SAT scorers and suggests learning these words in order of difficulty. Argues that the words in this set are not specialized terms, but rather words that are used regularly, and that most students in the low-SAT group probably recognize most of them, though they don't know their meanings.

Bowker, R., & Turner, V. (1976). *Effect of Lake Grove vocabulary building program on vocabulary percentiles* (Statistical Bulletin #1976-13). Boston: Human Engineering Laboratories. Examines effectiveness of a vocabulary program that involves students learning 10 words per week using traditional methods plus about 2 hours per week with O'Connor's Vocabulary Building Machine in improving overall vocabulary level as well as in helping students to learn the specific words taught. Because the words on the various tests given after the instruction were not those studied in the vocabulary building program, and because the scale is keyed to age, it is argued that the increases in vocabulary (25 of 28 subjects improved their percentile scores) represent overall gains in vocabulary level rather than the learning of specific words. The median percentile increase, from the 15th percentile to the 34th, was highly significant. Those with more than a year between test and retest showed an increase in median percentile from 18 to 44. Though the median time between testing and retesting was 10 months, the increase was equivalent to 2-1/2 years of normal vocabulary growth.

Chadwick, C. S. (1971). *Analysis of booklist, Worksample 379C, in relation to vocabulary level* (Tech. Rep. #756). Boston: Human Engineering Laboratories. Reports on correlations between vocabulary level and preference for reading material from 3,096 examinees ranging in age from teens to sixties. Subjects were asked in a questionnaire to list three books that gave them lasting pleasure. Many "children's books" were listed by adults and many "adult books" were listed by children. Concludes that the individual's reading ability and the level of difficulty of the book were principal criteria used by the subjects. Provides a list of the 20 most commonly selected titles along with the mean vocabulary score for those selecting it.

Connolly, B. L. (1946). *The first revision of the English Vocabulary Builder* (Tech. Rep. #305). Boston: Human Engineering Laboratories. Provides a list of the item-by-item changes made in the 1937/39 edition of O'Connor's English Vocabulary Builder for publication in 1948.

Daniel, M. (1977). What are the determinants of the order of acquisition of general vocabulary words? *Proceedings of the Johnson O'Connor Research Foundation/Human Engineering Laboratories Management and Research Meetings* (pp. 143-154). New York: Johnson O'Connor Research Foundation. Reviews literature related to what factors determine word difficulty or acquisition order and how the study of word difficulty relates to cognitive theory and vocabulary instruction. Provides extensive discussion of Miller's (1974) notion of procedural semantics, characterizing his notion of vocabulary acquisition as: "A new word is a capability to perform a new, more complex, operation. New words are built upon simpler, earlier capabilities. The acquisition of words, then, should be ordered along a dimension of processing complexity" (p. 147). Notes general agreement in the literature that word learning begins with recognition that the word belongs to a general category, and then proceeds by the addition of qualifiers and discriminators. Discusses semantic feature analysis and concludes that the level of difficulty of a word (or its order of acquisition) will be influenced by it semantic featural complexity. Defines knowing a word as "associat[ing] some set of 'qualifiers,' 'features,' or 'rules of application' with that word" (p. 150), and suggests that "the way to see if someone knows a word at a specified level is to see if he can accurately make the discriminations implied by the set of features that comprise that level" (p. 150).

Daniel, M. (1981a). *Changes in English vocabulary scores, 1979-81, by age and region* (Tech. Rep. #879/1981-6). Boston: Human Engineering Laboratories. Using a sample of 5,143 students, the report finds that "vocabulary scores increase from age 14 through the late twenties and level off in the early thirties" (p. 1). Finds some regional differences in average vocabulary level, with average teenage vocabulary levels having

increased recently in those regions that were already relatively high and with average teenage vocabulary levels having recently decreased in other regions.

Daniel, M. (1981b). *Vocabulary test errors and word learning* (Tech. Rep. #881/1981-8). Boston: Human Engineering Laboratories. Tests O'Connor's proposal that word learning involves four stages: (a) sound/look alike, (b) appropriate context, (c) general meaning (confuse with antonym), and (d) precise meaning. Finds that contrary to O'Connor's hypothesis, confusion with antonym occurs early in word learning process.

Daniel, M. (1983). *Correlations of aptitude tests with high school grades* (Tech. Rep. #892/1983-4). Boston: Human Engineering Laboratories. Examines correlations between aptitude test scores and both grades in 26 courses and overall indices of academic performance for 583 public school students, aged 15-17. Finds that five tests (English Vocabulary, Graphoria, Silograms, Analytic Reasoning, and Ideaphoria) tend to correlate most highly with grades, and that vocabulary correlates highly not only with overall academic success, but also with performance in math, English, social studies, economics, natural sciences, foreign languages, accounting, and typing.

De Silver, J. G. (1945). *An experiment in level of difficulty* (Tech. Rep. #200). Boston: Human Engineering Laboratories. Reports that the easiest 100 words of the 1,100 words in O'Connor's first volume of English Vocabulary Builder average 2.06 syllables, while the hardest 100 words average 2.99 syllables, and that the easiest 100 average 6.84 letters, while the hardest average 8.29. Gives averages for each group of 100, and concludes that a word's difficulty is not dependent to any great extent on its length since there is little difference between hard and easy words in either number of syllables or number of letters. Also considers the theory that easier words tend to be older words from Anglo-Saxon, while harder words tend to be words more recently entering the language, primarily from Latin and Greek, but notes that there are too many exceptions. Considers that word difficulty may be connected with concept difficulty. Argues that this implies that easier words would have been in the language earlier than hard words, and tests this by examining age of entry into English for the easiest 100 words in Vocabulary Builder and for the hardest 100 words. Finds a 100-year difference in means, with easier words being older on average than harder words and suggests that this difference is sufficient to merit further investigation.

Ferry, M. E. (1938). *Preliminary study of twenty problem students* (Tech. Rep. #27). Boston: Human Engineering Laboratories. Reports on the testing of 20 "problem students" in Grades 10-12 to determine whether their patterns of aptitudes and vocabulary deviated consistently from that of normal students. The students were tested as part of a larger group so that there would be no influence from them being singled out as different from normal. Most of the problem students possessed more aptitudes than normal, but not so much that this should have been a problem. As a group they differed most importantly from normals in that they were considerably below normal in vocabulary. Suggests direct instruction for this group.

Filley, M. E. (1939a). *The construction of the English vocabulary test: Worksample 95, Form DB* (Tech. Rep. #11). Boston: Human Engineering Laboratories. Describes at length the principles and procedures involved in the first revision of one of six roughly equivalent forms of Worksample 95, a major Human Engineering Laboratories vocabulary test consisting of 150 5-choice items presented in ascending order of difficulty that is intended for use with most examinees from Grade 9 through adult. Also includes good presentation of O'Connor's principles of vocabulary development.

Filley, M. E. (1939b). *Revision of Form AB leading for Forms AC and AD: Worksample 95* (Tech. Rep. #41). Boston: Human Engineering Laboratories. Describes revisions of an HEL vocabulary test that was not intended for use by HEL but that was made available to schools.

Filley, M. E. (1939c). *Revision of Form F leading to Forms FA and FB: Worksample 95* (Tech. Rep. #42). Boston: Human Engineering Laboratories. Describes second revision of an HEL vocabulary test to incorporate it as part of a battery of five equivalent vocabulary tests.

Filley, M. E. (1940a). *Revision of Form G leading to Form GA: Worksample 95* (Tech. Rep. #53). Boston: Human Engineering Laboratories. Describes the construction/refinement of one form of a major HEL vocabulary test. Notes an attempt to have an antonym for each test word as a mislead or distractor, a "concomitant," a malapropism, and a word of the same general category as misleads for each test word. Notes that for difficult words, antonyms are not generally good misleads, and that the most effective misleads in the test were malapropisms.

Filley, M. E. (1940b). *Revision of Form EA leading to Form EB: Worksample 95* (Tech. Rep. #55). Boston: Human Engineering Laboratories. Provides an item-by-item description of specific changes made in the second revision/refinement of an HEL vocabulary test.

Filley, M. E. (1940c). *Test words and mislead classifications of vocabulary forms G, H, I, Worksample 95* (Tech. Rep. #73). Boston: Human Engineering Laboratories. Describes item construction for three revisions of Worksample 95, the most widely used of the HEL vocabulary tests. Notes that "English vocabulary is an acquirable characteristic," and that "a large and precise knowledge of English words acts as a tool in assisting a person to make the best use of his inherent ability. It is a characteristic of successful people in every field of endeavor" (p. 1). Provides reasons for developing various equivalent forms of the test, among them that some examinees are retested every few years and that some who come to be tested have studied the English Vocabulary Builder.

Filley, M. E. (1941). *The construction of the English vocabulary test, Worksample 311* (Tech. Rep. #80). Boston: Human Engineering Laboratories. Describes construction of an experimental vocabulary test for young people that gives the definition of the word in a phrase with the four misleads and the correct choice following. Words were chosen that were listed as 2a or 2b frequency in Thorndike's (1932) book of 20,000 words.

Filley, M. E. (1946). *The construction of the English vocabulary test, Worksample 281, Form AA* (Tech. Rep. #271). Boston: Human Engineering Laboratories. Describes construction of a vocabulary test in which the definition of the test word is given and the examinee selects the word from among five choices.

Fleming, M. (1948). *An explanation of the Human Engineering Laboratory's classification of colleges according to accounting aptitude and vocabulary level and a listing of medical schools classified according to this system* (Tech. Rep. #457). Boston: Human Engineering Laboratories. Sorts colleges into three groups based on size and date of founding (which correlates with classical studies and more stringent requirements such as Latin and English). Suggests that students with high accounting aptitude (an aptitude involved in pencil and paper work such as writing papers) should go to large schools while those with low accounting aptitude should go to small schools. Recommends that students attend a college the mean vocabulary level of whose students is not radically different from their own so that they will neither be bewildered in their classes (which would presumably occur if most of the students were too far above them) nor be bored (if most of the students were too far below them). Recommends large, older colleges for those who score high in each test, large newer colleges for those who score high in accounting but low in vocabulary, and so forth. Classifies colleges within universities on the basis of the characteristics of the university with which they are affiliated.

Foley, J. M. (1954). *A study of married couples* (Tech. Rep. #601). Boston: Human Engineering Laboratories. Reports higher correlations between husbands and wives for knowledge of English vocabulary than for any of the other traits tested. Notes that this finding was expected, that it probably reflects similarity in educational and general background, and that other investigators have found it to be an important factor in marital compatibility.

Gelman, B. (1945). *A preliminary comparison of vocabulary levels with choice of reading material* (Tech. Rep. #176). Boston: Human Engineering Laboratories. Finds a relationship between vocabulary level and choice of reading material. Draws data from students who were asked to list three books they enjoyed reading. Correlates list with various factors, including vocabulary scores. Includes no information as to the number of subjects responding, but the procedures suggest that there must have been at least several hundred. Lists results for several books and authors.

Gershon, R. C. (1988). *Index of words in the Johnson O'Connor Research Foundation, Inc. vocabulary item bank* (Tech. Rep. #1988-3). Chicago: Johnson O'Connor Research Foundation. Lists item difficulties for the 3,081 words currently in the Foundation's vocabulary test item bank. The data are based on more than 30,000 public and private school students throughout the U.S., plus more than 5,000 Foundation examinees. The report presents the words in order of difficulty (based on 80% chance of getting the word right on a Foundation vocabulary test) and also lists the words in alphabetical order. Items in the Foundation's item bank have been tested to meet two criteria: first, the item had to be one generally answered correctly by people who did well on the test and incorrectly by those who did poorly, and second, it had to have been administered to examinees for whom it was at an appropriate level of difficulty--neither too difficult nor too easy.

Gershon, R. C. (1990a). *Age and education effects on VSS* (Statistical Bulletin #1990-4). Chicago: Johnson O'Connor Research Foundation. Examines effects of age and education on vocabulary level. Finds correlation of .59 between age and vocabulary score and .63 between age and years of education for 14,437 Foundation examinees aged 14-60. Regression analysis showed that age accounted for 40% of vocabulary variance. Provides curve of vocabulary score by age, which shows negatively accelerated decline in increase of vocabulary size with age. Also presents curves for 10th, 50th, and 90th percentile vocabulary scorers by age, each of which shows a relatively smooth curve with increase in vocabulary score declining with age. Education was almost linearly predictive of vocabulary score across the full range of educational levels tested (8-21 years), and a regression analysis showed that education accounted for 40% of variance. A third regression analysis showed that age and education jointly accounted for 46 percent of the variance in vocabulary score and that age and years of education were confounded, which was expected since some of the younger examinees were high school students, and thus presumably had less education, on the average, than older examinees. For examinees 30 and older, age was a relatively poor predictor of vocabulary score, but years of education was still important as a predictor of vocabulary score. Suggests that norms need to be established for people over 33, since vocabulary continues to increase beyond this age. Notes that it is unclear whether education is causally related to vocabulary or whether vocabulary is causally related to education.

Gershon, R. C. (1990b). *The vocabulary scores of managers* (Tech. Rep. #1990-5). Chicago: Johnson O'Connor Research Foundation. Extends a 1984 Foundation study, which showed that company presidents tend to have larger than average vocabularies, to other high-level managers. Finds that corporate managers (N = 379) tend to have vocabularies larger than those of similar aged average Foundation examinees, but smaller than those of company presidents, which supports O'Connor's assertion that people higher in an organizational hierarchy tend to have larger vocabularies. Also examines six lower managerial levels (N = 322) within a single company and finds that as a group, managers have a higher vocabulary level than do average Foundation examinees, but, that there was no statistically significant difference across levels after corrections for age were made. Notes importance of controlling for age in vocabulary studies.

Hamlin, T. F. (1947). *The first percentile in English vocabulary and its growth with age* (Tech. Rep. #357). Boston: Human Engineering Laboratories. Examines the 400 words at the lowest level of difficulty in O'Connor's revised English Vocabulary Builder (1948), which are known to practically all adults, to establish an order of difficulty within this group of words based on age of acquisition. Data, based on 1,484 subjects aged 9-17, enable the division of the 400 words in the "known to practically all adults" category into 12 categories ranging from "known to practically all 9 year olds," proceeding year by year to "known to practically

all 20 year olds," with 69 of the 400 words left in the "known to practically all adults" category. Reports that 200 of the 400 words fall into the last four categories.

Hamlin, T. F., & Reich, C. F. (1958). *A classification of books according to the sex and vocabulary scores of those choosing them* (Tech. Rep. #630). Boston: Human Engineering Laboratories. Reports results of a study that asked 2,292 people to list books they had enjoyed reading. Correlates each book that was listed by 15 or more people with the average English vocabulary score of the people listing the book. Provides a list of 62 books grouped by sex and vocabulary level of the people who listed them.

Human Engineering Laboratories. (1935). *A study of the English vocabulary scores of 75 executives* (Tech. Rep. #2). Boston: Human Engineering Laboratories. Finds that large vocabularies (assessed by a 150- question multiple-choice test) occur more frequently among executives ($N = 75$, $M = 138$) than among college graduates ($N = 1000$, $M = 122$). Reports that within the executive group, 25 high-level executives had a mean of 141 words correct out of 150, while the mean score for 250 non-college graduates was 117 words. Finds no correlation among executives between age and vocabulary and no significant difference in vocabulary size between men and women executives. Among executives, officials (business heads) had larger vocabularies than supervisors (those subordinate to an official).

Human Engineering Laboratory. (1935). *The common responses to a new form of the free association test* (Tech Rep. #3). Contains list of responses of 400 individuals to 100 words presented in free association tests. Provides the 10 most common responses to a new form of the free association test.

Human Engineering Laboratories. (1935). *First revision of form E of the English vocabulary test: Worksample 95* (Tech. Rep. #5). Boston: Human Engineering Laboratories. Describes reasons for and procedures involved in revision of one form of Worksample 95, the most widely used HEL vocabulary test.

Human Engineering Laboratories. (1936). *A study of the physics technical vocabulary test: Worksample 181* (Tech. Rep. #7). Boston: Human Engineering Laboratories. Notes that "no technique is known by which it is possible to teach words rapidly and accurately. Classes which have had the importance of vocabulary pointed out to them, improve almost as rapidly as experimental groups especially drilled in vocabulary" (p. 1). Studies acquisition of technical vocabulary terms from physics to see if it follows O'Connor's principles of vocabulary acquisition. Discusses problems and principles of test construction in the course of describing the development and norming of revised forms of two physics vocabulary tests. Urges further revision of these tests before they are made available outside the Laboratory. Concludes that "normal improvement is roughly four words a year in a 50-item vocabulary test in the lower classes of an engineering school. Assuming a Physics vocabulary of about 500 terms a four word improvement in score means acquisition of roughly 40 new terms in the year's time. It is probably practical to place sufficient emphasis on vocabulary to teach two or three times this number in a year" (p. xxiii). Argues that O'Connor's first principle--that each word has an inherent level of difficulty--applies to physics vocabulary because some words were known to almost all subjects and some were known to almost none.

Human Engineering Laboratories. (1936). *A two year follow-up of 58 student nurses* (Tech. Rep. #8). Boston: Human Engineering Laboratories. (A follow-up to Tech. Rep. #1.) Reports that after 6 months of schooling, and also after 12 months of schooling, all those student nurses who were required to repeat courses were below the mean of successful graduate nurses in vocabulary, as were all who were dropped for poor ward work. All who were dropped due to poor scholarship were not only well below the mean of successful nurses but were also below the mean of their satisfactory classmates. Again at the end of the program, at which time 33 of the original class of 60 remained, the same pattern of means and conditions remained. Those who were dropped for poor scholarship were characteristically low-vocabulary individuals. All student nurses who scored above the mean and who did not leave voluntarily for personal reasons (of which there were three cases) completed the course of study successfully. Those with vocabulary scores below the mean for the incoming class had a

less than 50% chance of successful completion, and the probability of failure increased as vocabulary score decreased. The three who left voluntarily for personal reasons had a mean vocabulary score well above the class mean.

Johnson O'Connor Research Foundation. (1976). *Vocabulary building: The Lake Grove experience* (Statistical Bulletin #124). Boston: Johnson O'Connor Research Foundation. Reports on the work of Bowker and Turner with the Lake Grove school (Statistical Bulletin #1976-13). Concludes that vocabulary can be improved, but that it requires a positive environment, enthusiasm, and a program that presents words that are at an appropriate level of difficulty.

Jones, G. (1975). *Construction of a new easy vocabulary test, Worksample 679A* (Tech. Rep. #836). Boston: Human Engineering Laboratories. Describes development of a vocabulary test intended to provide more words in the easy range of word difficulty. Used word frequency to approximate word difficulty because the Laboratory has no accepted criterion for evaluating the difficulty of target words or misleads until they are used in a test. Thorndike and Lorge (1938/44) and Kucera and Francis (1967) were the primary sources for word frequency, and Shaw and Shaw (1970) was used as a "backup reference." Notes weaknesses in using word frequency counts as measures of word difficulty.

Licht, M. H. (1944). *The effects of a large vocabulary on other worksample scores* (Tech. Rep. #135). Boston: Human Engineering Laboratories. First tests 134 examinees to determine whether high- vocabulary individuals obtain more high aptitude scores than low-vocabulary individuals. Finds a tendency in this direction, but because studying four aptitudes proved too unwieldy, the second part of the study examines only the aptitude of structural visualization, which showed the most striking results in the first part of the study. The second part of the study tests three groups of 200 males, aged 16, 17, and 30-34. Results suggest that the vocabulary used in the aptitude test is too difficult for very low-vocabulary individuals, and that limitations in vocabulary knowledge may influence aptitude test scores.

Licht, M. H. (1947). *The relationship between English vocabulary and technical knowledge* (Tech. Rep. #385). Boston: Human Engineering Laboratories. Notes that vocabulary level "appears to be a measure of general knowledge, and correlates highly with success in all fields" (p. 1), and that "as words increase in difficulty they tend to become more technical" (p. 1). Tests four subjects with high general vocabulary scores for knowledge of technical vocabulary in specific areas to test hypotheses that a high level of technical vocabulary knowledge results from high general knowledge versus that it results from extensive study in the specific technical areas. Finds that "high vocabulary people score higher in most of the fields of specialized knowledge than do low vocabulary people, whether or not they have studied those specific fields" (p. 4). Supports the theory that an individual acquires new knowledge by relating it to earlier knowledge.

Luqueer, M. O. (1940). *Relationship of English vocabulary scores to placement in school* (Statistical Bulletin #616). Boston: Human Engineering Laboratories. Examines 3,148 college students and large numbers of high school students and finds that a low vocabulary score correlates with retardation in school, and, though less so, that a high score correlates with advancement in school work. Finds that each year's displacement from the normal school grade, either up or down, corresponds to an average difference of 16 percentiles in vocabulary score. Finds lower correlation between vocabulary score and attainment in school at older ages.

Luqueer, M. O. (1943). *Preliminary study of the relationship of test scores to success or failure in school* (Tech. Rep. #102). Boston: Human Engineering Laboratories. Based on 9,067 cases, reports that English vocabulary correlates highly with success in school. Low scores consistently accompany retardation in school and, to a lesser degree, high scores accompany advancement in school. Correlations are lower for older students. Concludes that education cannot account entirely for vocabulary level.

McAveeney, T. (1964). *A study of English vocabulary scores and school performance of women students in a two year retailing school* (Tech. Rep. #661). Boston: Human Engineering Laboratories. Finds fairly strong correlations (.42 to .66) between vocabulary level and school grades for two groups of vocational school students (N = 95/group). Low-vocabulary students tended to flunk out; high-vocabulary students tended to leave voluntarily.

McLanathan, F. L. (1941). *Learning process in English vocabulary as shown by words of similar sound, Vol. I* (Tech. Rep. #94). Boston: Human Engineering Laboratories. Tests the hypothesis that early in the course of learning a word, the word tends to be confused with words that are similar in sound to it. Concludes that similar-sound misleads are effective primarily with the lowest groups, and that this indicates getting some idea of how a word sounds is one of the first steps in the learning the word.

McLanathan, F. L. (1942). *Learning process in vocabulary shown in opposite and malapropistic misleads, Vol. II* (Tech. Rep. #94). Boston: Human Engineering Laboratories. Tests the hypothesis that confusing a word with its antonym occurs late in the course of word acquisition. Suggests that for a low level test word, only the lowest vocabulary people will mark an opposite mislead, while for a harder item, higher vocabulary individuals will mark the opposite mislead, and low-vocabulary people will mark some more obvious mislead, such as a similar-sound mislead. Supports the Laboratory's position that a person who confuses a word with its antonym is close to acquiring the meaning of the word. Finds that malapropisms cause the most confusion among low-vocabulary individuals, but that such misleads are more effective than are similar-sound misleads. Notes the possibility of confounding variables, urges further study regarding the suitability of malapropisms as misleads. Concludes that confusion of a word with its antonym is one of the last stages in the acquisition of a word's meaning, occurring further along in the learning process than does confusion of the word with a similar-sounding word.

McLanathan, F. L. (1943). *A graphical analysis of English vocabulary, Worksample 95, Form D* (Tech. Rep. #95). Boston: Human Engineering Laboratories. Investigates the role of chance in tests of general vocabulary knowledge. Proposes a new way of examining mislead responses based on the response patterns to each item of different quartiles of examinees in an effort to more closely approximate the order of difficulty of words and to further refine vocabulary tests. Plots response curves for test items using this system in an attempt to determine what types of curves may indicate more ideal test items.

O'Connor, E. M. (1971). *Johnson O'Connor English Vocabulary Builder, Volume III, Part I.* New York: Human Engineering Laboratories. Contains 150 words for use with the top quarter of seventh graders and the third quartile of high school seniors. Presents words following the standard O'Connor format.

O'Connor, J. (1928). *Born that way.* Baltimore: Williams & Wilkins. Provides a wealth of information about aptitudes and also presents O'Connor's early ideas about vocabulary.

O'Connor, J. (1934, February). Vocabulary and success. *Atlantic Monthly*, pp. 160-166. Argues that vocabulary size correlates highly with success in virtually all occupational endeavors. "An extensive knowledge of the exact meanings of English words accompanies outstanding success in this country more often than any other single characteristic [we] have been able to isolate and measure" (p. 160). Reports results of a 150-item test, graduated from easy to difficult. High school students averaged 76 errors; college freshmen, 42 errors; college graduates, 27 errors; college professors, 8 errors; and major executives, 7 errors--a higher average score than was obtained by any other group. Argues that "Words are the instruments by means of which men and women grasp the thoughts of others and with which they do much of their own thinking. They are the tools of thought" (p. 163). Argues, too, that a large vocabulary consistently precedes success. Claims that schooling does not, in itself appear to result in high vocabulary. Notes that the vocabularies of 20 successful men who had left school at age 15 averaged just as high as those with college degrees, and concludes that it is the richness of an individual's vocabulary that is important for success, rather than his formal school education.

Claims that, "Vocabulary advances with an almost unbroken front. The words at the command of an individual are not a miscellany gathered from hither and yon. With a very few exceptions they are all of the words in the dictionary up to those of an order of difficulty at which his vocabulary stops abruptly, and almost no words beyond" (p. 165).

O'Connor, J. (1934). *Characteristics of graduate nurses* (Tech. Rep. #1). Boston: Human Engineering Laboratories. Assesses the vocabulary of 78 graduate (practicing) nurses and of 60 and who were beginning training. Graduate nurses were approximately equal in vocabulary level to college graduates. Finds that all nine of the first group of students who were dropped from the program were low in vocabulary. Four others who were not dropped but were required to repeat also had vocabulary levels below the mean of successful nurses.

O'Connor, J. (1935). *Psychometrics*. Cambridge, MA: Harvard University Press. Provides an in-depth treatment of assessment of human aptitudes. Includes graph of vocabulary by age, which shows gradual decline in rate of increase of vocabulary with age (based on 5,099 subjects).

O'Connor, J. (1940). *Unsolved business problems*. New York: Human Engineering Laboratory. Describes a study in which 100 college seniors studying to become industrial executives were given a vocabulary test. Reports that all students in the top 10% became executives, while none in the bottom 25% did.

O'Connor, J. (1948). *The unique individual*. New York: Human Engineering Laboratories. Discusses personality factors, aptitudes, and vocabulary and their relationship to occupational and other factors. Presents O'Connor's basic principle that new words must be learned in their natural order, the easiest first, and then the more difficult, each resting on others beneath." . . . One who laboriously commits to memory some hard word before the easy ones, remembers it only momentarily and largely squanders his labor" (p. 152). Argues that a word's difficulty level is best determined on the basis of the percentage of people who get it wrong in a controlled test.

O'Connor, J. (1948/74). *English vocabulary builder, Volumes I, II, and III*. Boston: Human Engineering Laboratory. *English vocabulary builder* is a series of three vocabulary instruction texts that incorporates O'Connor's principles of vocabulary learning. The books present the first extensive instructional application of O'Connor's principles of vocabulary acquisition. Each entry consists of the new word that is the focus of the instruction followed by a fairly lengthy definition of the word and several of the following: synonyms, antonyms, morphologically related forms and their definitions, examples of the word used appropriately, etymological information, morphological analysis, and other mnemonic devices to help the reader develop associations between the to-be-learned word and already known words and concepts. The words progress from easy to hard as you proceed through the book, each word's difficulty level having been ascertained on the basis of the percentage of the general population to whom the word's meaning is not known.

O'Connor, J. (1956). *Science vocabulary builder*. Boston: Human Engineering Laboratory. An instructional text employing O'Connor's principles for the teaching of technical science vocabulary. Its format is essentially the same as that employed in O'Connor (1948/74).

O'Connor, J. (1958). *Item-by-item study of English Vocabulary Test, Worksample 95 Form EB leading to Form EC* (Tech. Rep. #624). Boston: Human Engineering Laboratories. Describes the second revision of the E series of Worksample 95 based on item analysis data consisting of more than 100,000 clerical entries collected from thousands of subjects. Notes that the goal of each revision is to have the choices for each item consist of (a) the correct answer, (b) an antonym of the correct answer, (c) a word fairly near in meaning (a near mislead), (d) a word used in the same situation as the test word, but different in meaning.

O'Connor, J. (1964). *Learning words. Ginn high school English notes, No. 2*. Needham, MA: Ginn. Claims that word difficulty is consistent across geographic areas of the U.S.

O'Connor, J. (1969). *The vocabulary building program* (Tech. Rep. #715). Boston: Human Engineering Laboratories. Describes use by the members of the steering committee of the Massachusetts Diatetics Association of machines developed by Andrew Kay of Non Linear Systems that can present the entire 2,151 vocabulary system contained in the first two volumes of *English Vocabulary Builder* (O'Connor, 1948/74) audiovisually. Although these individuals were scheduled for 10 weekly 30-minute sessions, the subjects maintained interest for an average of 2 hours. Finds an almost linear increase in error rate upon first encounter with a word as difficulty level of word group increased. Finds a decrease in error rate of approximately 50% or greater for a second exposure to a set of 100 target words when a subject repeated that level a week later. Notes that learning is very effective for words whose difficulty level is at one's personal vocabulary boundary or frontier, but that learning rate is much lower for words at a level which is too difficult given that person's vocabulary level. Finds that those subjects who read through a whole level from beginning to end and then reread it improve more than those who study each word repeatedly until they think they have learned it. Of the 415,000 words defined in the Oxford English Dictionary, "178,000 are considered current. A surprisingly large proportion of these are known to every adult. Many others are easily recognized forms of some one word, as: epitome, epitomize, epitomizing, epitomized. Perhaps as few as 5,000 additional words would lift an adult from the 20th percentile to the 80th" (pp. 6-7). Notes that individualized instruction is approximately 3-1/2 times as efficient as class instruction. Reports a faster rate of vocabulary growth occurs for those in higher percentiles than those in lower percentiles during the four college years (N = 23,000). Notes that low-vocabulary individuals can improve as much as high-vocabulary individuals, provided the low-vocabulary individual starts at the appropriate level. Claims that with new technology, HEL is now increasing people's vocabularies at approximately five times the normal rate. In the course of the 12-week, 2-hours-per-week program, O'Connor finds a learning rate 3-1/2 times that found with a typical group classroom approach to vocabulary instruction.

O'Connor, J. (1970). *Civil disorders* (Statistical Bulletin #74). Boston: Human Engineering Laboratory. Proposes that low vocabulary is a major source of frustration and crime. Claims that vocabulary can be taught, that everyone can learn words, that there is no evidence of a limiting ceiling for vocabulary, and that vocabulary knowledge gained through direct study is apparently equivalent in nature to that acquired naturally. "Though it is difficult to prove on a national basis, such evidence as we have, which extends back 48 years, suggests that every word learned reduces a bit the chance of crime and violence" (p. 2). Claims that rate of vocabulary acquisition gradually slows down starting at about age 10, and continues slowing throughout life, fitting a smooth mathematical formula. Observes that a study based on 29,000 people suggests that "neither high schools nor colleges contribute to [rate of growth of] English vocabulary" (p. 2). Claims that order of word difficulty and acquisition "is the same in California, Texas, Illinois, New York and Massachusetts, and is not dependent on some school, textbook, or teacher" (p. 2). States that "today's high schools and colleges fail to improve the English vocabularies of their students" (p. 2).

O'Connor, J. (1972). *General intelligence* (Bulletin #103). Boston: Human Engineering Laboratory. Discusses high spots of fifty years of research. Intelligence is not a holistic phenomenon, but the result of a set of independent aptitudes. Presents three principles of vocabulary acquisition. "First; it is possible to arrange words in order of difficulty, from easy at the beginning to hard at the end, an order inherent in the words themselves, or more probably in the ideas which the words convey" (p. 2). Second, "Each person knows all, or practically all, of these words in order of difficulty, up to a point where his knowledge becomes doubtful, and knows practically no words beyond this point" (p. 3). Third, "Rate of learning is greatest just at the border of one's vocabulary" (p. 3). States that there are approximately 178,000 words in current use (of the approximately 450,000 in the Oxford English Dictionary). Estimates that a fifth percentile 20-year-old can select the correct meaning of approximately 33,000 words (by dictionary count), while a 95th percentile individual would have the same level of knowledge of approximately 108,000. Estimates that in terms of root words, these numbers are probably somewhere on the order of one tenth these figures, and suggests that for an adult to improve his or her vocabulary level from very low to very high would require the learning of something on the order of 3,500 words. Argues that students' difficulties with vocabulary arise because of the

unwillingness of schools to start vocabulary instruction at a low enough level for low-vocabulary learners. Concludes that, "A large and exact English vocabulary seems today much what general intelligence appeared fifty years ago. It precedes worldly success in most every direction, checks with money earnings, and proves essential to school and college entrance and survival" (p. 4).

O'Connor, J., & Filley, M. E. (1933). A junior English vocabulary test. *Personnel Journal, 12*(4), 204-212. Tests students in Grades 5-8 on a version of a vocabulary test. Finds that those who knew the harder words on the test invariably knew the easier ones. Argues that it's a waste of time to test students on vocabulary items below their level because they know virtually all such words, and suggests that tests should be geared to the general level of the test takers.

Parsons, T. W. (1956). *Construction of the 1955 age norms for English vocabulary* (Tech. Rep. #616). Boston: Human Engineering Laboratories. Describes the procedures followed in obtaining new percentile norms for English vocabulary by the use of mathematically fitted curves (p. 3). The data were obtained from 29,257 people from seven areas of the country. Computes vocabulary growth norms by various methods, including median age against English vocabulary General Scale Score, which shows a smooth hyperbolic curve with the rate of vocabulary increase decreasing with age.

Phillips, P. S. (1945). *Vocabulary improvements in second test appointments* (Tech. Rep. #166). Boston: Human Engineering Laboratories. Examines test-retest scores of 35 examinees. Length of time between tests ranged from 9 months to 5.9 years. Finds that those who were retested had improved at a faster rate than is normal for their ages and the time interval involved.

Phillips, P. S. (1946). *Vocabulary level at second test appointment* (Tech. Rep. #264). Boston: Human Engineering Laboratories. Finds larger gains in vocabulary for return examinees than for the population at large. The largest gains for average vocabulary level people, aged 9-14, occurred when the interval between tests was not greater than three years.

Ransom, D. (1972). *Study of parent-child English vocabulary* (Tech. Rep. #747). Boston: Human Engineering Laboratories. Compares the English vocabulary scores for 200 sets of one parent and one child to test various genetic hypotheses regarding verbal ability as measured by vocabulary tests. Finds a correlation of .358, but notes that the data are not conclusive and that the HEL does not believe that genetic factors are particularly strong for vocabulary acquisition. Notes that parents "generally provide both the genetic constitution and the primary environmental influence for their children" (p. 3). Notes that despite the findings, the HEL believes that vocabulary develops in response to the individual's environment.

Seeley, L. C. (1940). *Comparison of vocabulary scores of college graduates with those of non-graduates for ages 25-50* (Statistical Bulletin #552). Boston: Human Engineering Laboratories. Finds that the vocabularies of both college graduates and non-college-graduate males increase between the ages of 25 and 50. The rate of acquisition of new vocabulary during this period is considerably faster for graduates than for nongraduates.

Shambaugh, I. (1969). *Reading speed and comprehension research; Worksample 635, Form AA; Correlations with graphoria and English vocabulary, and item-by-item analysis of reading comprehension* (Tech. Rep. #717). Boston: Human Engineering Laboratories. Finds that both speed and comprehension correlate with vocabulary. Notes that, in general, high-speed readers get less information than slower readers.

Sidserf, E. H. (1939a). *Study of vocabulary improvement* (Statistical Bulletin #265). Boston: Human Engineering Laboratories. Reports the results of a study by the Works Project Administration showing that vocabulary continues to improve for many months after administration of a vocabulary test, but that rate of improvement decreases rapidly from 1 to 7 months after administration of the first test, and asymptotes at an improvement of .44 (on the General Scale) per month beyond 43 months.

Sidserf, E. H. (1939b). *Study of vocabulary improvement* (Statistical Bulletin #292). Boston: Human Engineering Laboratories. This report, a continuation of Statistical Bulletin #265, plots total vocabulary score improvement as a function of number of months between first and second vocabulary tests. The curve rises with a very steep slope until 7 months between tests (indicating a rapid rate of vocabulary acquisition during this between-test period), after which the rate of vocabulary acquisition falls off.

Sidserf, E. H. (1940). *English vocabulary distributions converted to the general scale for forty-two secondary schools* (Tech. Rep. #58). Boston: Human Engineering Laboratories. Examines vocabulary score distributions for students in Grades 9-12 at 42 schools in the eastern half of the U.S. with the purpose of recommending schools to students based on their vocabulary score relative to the mean of a school in their area. The premise is that a student will learn the most by attending a school the mean vocabulary level of whose same-aged students is neither too far above nor too far below the student's level. Vocabulary levels varied over a wide range for most classes, and means of classes varied over a wide range across schools.

Sidserf, E. H. (1941). *The 95EA scale and the general scale for the English-vocabulary tests* (Tech. Rep. #84). Boston: Human Engineering Laboratories. Describes procedures for establishing conversion equivalents between different vocabulary tests developed by HEL. This test form was normed on 8,765 students aged 13-21. Finds similar vocabulary knowledge patterns for males and females.

Smith, R. M. (1987). *Assessing partial knowledge in vocabulary.* Journal of Educational Measurement, 24.3, 217-231. Provides empirical support for O'Connor's multiple stages of acquisition theory.

Smith, R. M., & Supanich, G. P. (1984). *The vocabulary scores of company presidents* (Tech. Rep. #1984-1). Chicago: Johnson O'Connor Research Foundation. Retests O'Connor (1940) with 50 question test. Corroborates O'Connor's results: company presidents as a group scored above the mean of those tested by the Foundation (average of testees is 16 years education). "Half of the company presidents scored at or above the 75th percentile for the norm group. Only 12% . . . scored below the mean" (p. 5-6). "The small positive correlation between Vocabulary Scale Scores and both age and years of education indicates that age and years of education only marginally account for the variation in vocabulary scores" (p. 6).

Sprague, R. E. (1938). *Revision of Form C of the Physics Technical Vocabulary Test, Worksample 181, on the basis of new criterial ratios* (Tech. Rep. #20). Boston: Human Engineering Laboratories. Describes principles and procedures for the first revision of one form of a test designed to assess vocabulary knowledge of physics terms based on responses of 400 subjects to whom the earlier form was administered. Describes and uses a "revised method" of item analysis based on distribution rather than the upper quartile method that had been used previously for revisions. (Tech. Rep. #7 provides a description of the construction of the original form of this test.)

Stitt, R. H. (1954a). *A new criterion for the construction of English vocabulary worksamples* (Tech. Rep. #605). Boston: Human Engineering Laboratories. Notes correlations generally in the .5 range between word frequency and word difficulty based on various HEL vocabulary test forms. States that "a perfect vocabulary test should have words arranged in a constantly accelerating order of difficulty; the curve of difficulty should be a straight line throughout the range of the test with the slope of the line determined by the length of the test and by other factors" (p. 3). Notes that O'Connor's Vocabulary Builder is heavily weighted for very easy and very hard words and that "such an attenuation of the 40 to 94 percent region of the scale vitiates to too great an extent the usefulness of the Vocabulary Builder for persons scoring between those levels" (p. 6). Discusses test construction for assessing the vocabularies of examinees at various levels. "To minimize or attenuate the effect of guessing, . . . have several classifications such as opposites, correct meaning, same field, similar sound, and other listed on the page, and ask the examinee to identify all misleads as well as the correct meanings" (p. 10). Plots various versions of HEL tests and notes deviations from a "perfect" test. Notes a reasonably close approximation of forms IA and AC to the "Universal test line," which would characterize the

perfect test. Also notes the possibility that there are relatively few words of intermediate difficulty. Recommends that short (15-item) tests of "new" words be given to all HEL examinees to establish a larger, unbiased corpus of words ranked by order of difficulty.

Stitt, R. H. (1954b). *The T-funnel shape of frequency of words* (Tech. Rep. #606). Boston: Human Engineering Laboratories. Suggests that the true correlation between word difficulty and word frequency is higher than the .5 found in Tech. Rep. #605. Concludes that "It is . . . apparent that the shape of the frequency figure is that of a funnel which very closely approaches the letter T, greatly exaggerated. Since there is this very significant correlation between frequency and difficulty there exists the strong possibility that the shapes of the graphs of the two factors will be similar" (p. 4). That is, there are few words that are very high frequency words and large numbers of words that are low frequency; since word difficulty correlates fairly strongly with word frequency, the same is likely to be true for word difficulty.

Stitt, R. H. (1954c). *Silograms -- Worksample 376: A Thorndike critique of Forms AC and B and suggestions for research* (Tech. Rep. #607). Boston: Human Engineering Laboratories. Finds that virtually all real English words paired with nonsense words in the Silogram tests (both forms) are high-frequency words, and that thus word difficulty is not a factor in performance.

Stitt, R. H. (1966). *A study of the relationship between difficulty and frequency of appearance of certain selected adjectives.* Unpublished manuscript. Tests word difficulty (defined on the basis of order in O'Connor's English Vocabulary Builder) and word frequency (based on Thorndike & Lorge, 1944). Finds correlations for various tests to be approximately .5 for an easy test, .54, .52, and .53 for tests of intermediate difficulty, and .36 and .39 for very difficult tests. The rank order correlation for Anglo-Saxon adjectives, .22, did not differ from chance.

Strickland, F. (1971). *A short history of the English vocabulary work of the Human Engineering Laboratory Incorporated plus a discussion of the integration of 629CA and 95BC in preparation for a second expansion of the vocabulary builder* (Tech. Rep. #741). Boston: Human Engineering Laboratories. Reports that O'Connor's work on vocabulary began as a continuation of work begun by Alexander Inglis. Upon Inglis' death, Harvard University requested that O'Connor continue with the work that Inglis had begun. Discusses test construction and notes that the HEL's tests were normed on thousands of people and gradually refined over many years. He also discusses procedures for norming across tests.

Supanich, G. P., & Ingram, B. (1985). *Analysis and revision of Worksample 708* (Tech. Rep. #1985-4). Chicago: Johnson O'Connor Research Foundation. Documents the second revision of Worksample 708, a 50-item vocabulary test designed in accordance with O'Connor's theory of word acquisition. Each item contains 5 choices; (a) a synonym of the test word, (b) a close mislead, (c) an antonym of the test word, (d) a context mislead, and (e) a synonym of a word that looks like and/or sounds like the test word. O'Connor's theory suggests that the alternative an examinee selects for an item will be related to that examinees' vocabulary level, with the lowest-level examinees choosing the look-like/sound-like alternative, intermediate-ability examinees selecting the antonym, higher-ability examinees picking the close mislead, and with those who know the meaning of the word answering correctly. Revision is based on the test responses of 1,294 Foundation examinees. Notes that with the original form between 30 and 40% of the items were in reasonable accord with O'Connor's theory.

Wells, W. C. (1966). *Preliminary comparative study of the origins of easy and difficult words based upon the Human Engineering Laboratory developed Ginn Vocabulary Program, Test A and Test F* (Tech. Rep. #673). Boston: Human Engineering Laboratories. Examines the hypothesis that one source of word difficulty is language family background--that Anglo-Saxon words are easier than Latinate words. Examination of Form A (the easiest form) of the Ginn Vocabulary Program revealed that only one of the 150 words on the test is traceable to Teutonic and only 28 are traceable to Anglo-Saxon despite the fact that Anglo-Saxon is claimed

to be the language of the common man. Of the 150 words, 108 are traceable to Middle English, but not farther back, and 104 can be directly traced to French, despite the fact that many would maintain that such words should not be among the words of a basic English vocabulary. Examination of Test F (the hardest test form) revealed fewer words of French origin, more words directly from Latin, and more words of Greek derivation. "Words of trade and business have diminished from thirty-seven to three. . . . Fifty-seven of the words, or over one-third, are direct reflections of pure learning and scholarship" (p. 5). Finds that harder words are, as a rule, somewhat longer than easier words. Suggests that high-vocabulary individuals have "a marked superiority in being able to describe more precisely and in more varied ways than can the person of low vocabulary. . . suggest[ing] that the person with a large vocabulary is not only conversant with a broader field of knowledge, but that he can more accurately differentiate between similar concepts. He has a nice ability to refine his thinking" (pp. 5-6). Notes the possibility that simpler vocabulary might show a higher percentage of Anglo-Saxon words.

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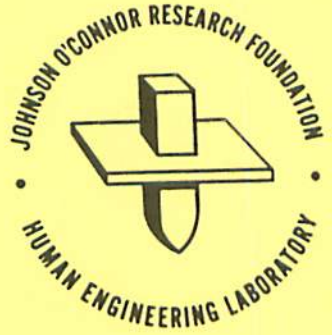
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